LOOKING FOR VOLCANIC ASH DEPOSITS WITHIN THE INTERIOR LAYERED DEPOSITS OF VALLES MARINERIS, MARS – PHYSICAL AND CHEMICAL CHARACTERISTICS OF ASH FALLS AND FLOWS. M.A. Matiella Novak[1], C. Viviano-Beck[1], K. Seelos[1] and D. Buczkowski[1] , [1]Johns Hopkins University Applied Physics Laboratory, 11101 Johns Hopkins Road, Laurel, MD 20723.

Introduction: Candor, Ophir, and Ganges Chasmata, located within Valles Marineris, Mars, contain Interior Layered Deposits (ILDs). Previous geologic mapping has shown that ILDs are regional formations and contain deposits that are widespread through Valles Marineris. While the formation of these features remains somewhat enigmatic, one leading hypothesis suggests that some layers within the ILDs may be composed of explosive volcanic deposits, comparable to the Bishop Tuff ignimbrite of Long Valley Caldera, CA [1].

This investigation aims to advance our understanding of how volcanic deposits may have come to exist within these chasmata and how subsequent surface processes altered these deposits. We will accomplish this by: 1.) Characterizing the physical and mineralogical properties associated with ILDs suggested to be of volcanic origin within the Candor, Ophir, and Ganges chasmata; 2.) Determining how the mechanical and chemical alteration of these features are related to what we currently understand about geomorphologic and climatologic changes through time on Mars' surface; and 3.) Comparing these features and deposit characteristics (extent, thickness, etc.) with current models of volcanic activity on Mars and the emplacement of explosive material in the region. The insight gained through this work will test the explosive volcanic formation hypothesis, contribute to our knowledge of the origin and evolution of ILDs, as well as our understanding of regional volcanic and tectonic processes, and timing thereof.

ILDs in the Valles Marineris Canyon System: ILDs are characterized as eroded plateaus up to several kilometers in relief, whose major occurrences are on the floors of Tithonium, Hebes, Ophir, Candor, Melas, Eos, and Ganges Chasmata. The term "layered" is a general description as the morphological development of layers varies from chasma to chasma [2]. Proposed source mechanisms for the ILDs include subaerial fluvial deposition or volcanism [3], accumulation of eolian dust or sand, evaporate precipitation, or subaqueous volcanism. In this study we focus on those layers where the suggested mechanism of origination is due to subaerial volcanism, i.e. explosive ash falls or flows.

Volcanic Activity in Tharsis Plateau: Earth's geologic record contains numerous layers of volcanic ash that are useful in correlating global stratigraphy because of their widespread distribution [4], so studying the record of volcanic ash deposits on Mars could also provide this same type of stratigraphic correlation on a regional or even global scale. The presence of volcanic ash falls within the chasmata ILDs of Valles Marineris have been suggested by numerous studies, e.g., [2],[3],[5],[6], as well the presence of consolidated volcanic ash material (i.e. welded tuffs) [1]. With its close proximity to the Tharsis Volcanic Plateau, the presence of diverse types of volcanic material within the ILDs is likely. Furthermore, if volcanoes in this region are the source of ash layers within the ILDs then it's reasonable to assume that the physical characteristics of these deposits would change in both thickness and particle size with distance from the source, and in fact, initial observations in this region suggest this trend exists [4,5]. To further test these observations with mineralogical data, we have chosen three chasmata that are positioned in increasing distances from the possible source of material in Tharsis.

Volcanic Deposits Within ILDs: Previous studies of Valles Marineris chasmata have mentioned the presence of possible volcanic ash deposits within the ILDs. For example, [6] analyzed the geomorphological and mineralogical characteristics of Hebes Chasma and found that the downslope dipping of ILD layers is in agreement with a draping process consistent with pyroclastic ash falls originating from a W-E trending volcanic vent, or a series of WNW-ESE trending vents in an echelon alignment. Likewise, evidence for volcanic ash in Candor Chasma has been suggested through the identification of spectral signatures consistent with the evaporation of saline groundwater discharge cementing and diagenetically modifying eolian sand, dust, and possibly volcanic ash [2].

The presence of volcanic ash falls and flows has been disputed by [4] based on geomorphological assessments of the ILDs. These reasons included a lack of widespread volcanic ash debris on the surrounding plains and the absence of unambiguous volcanic calderas within the Valles Marineris chasmata [4]. However, all of these conclusions were reached based on geomorphological analyses using Mariner 9 and Viking imagery, and did not include a mineralogical assessment. More recent studies using newer data sets with better spatial resolution and better coverage than Mariner 9 and Viking data (e.g. [5]**)** have concluded that friable layered deposits (FLDs) near the Valles Marineris regions are likely to be of volcanic origin, noting that thinning of deposits with increasing distance from the Tharsis rise could be the result of explosive eruptions in the Tharsis region, and that Martian winds could have easily transported volcanic ash east along the equator, where they would have been deposited near the Valles Marineris region. In order for these deposits to have reached the area east of Valles Marineris, where [5] observed them, they would have passed over the chasmata within Valles Marineris, and likely ash fall out would have contributed to the chasmata ILDs.

Data: We are using data from the CRISM (Compact Reconnaissance Imaging Spectrometer for Mars) instrument on board the Mars Reconnaissance Orbiter (MRO) for mineralogical analysis as well as data from the THEMIS (Thermal Emission Imaging System) instrument on board the MO (Mars Odyssey) spacecraft for thermophysical analysis of the layers. We are also utilizing imagery from the CTX (Context Camera, MRO) and HiRISE (High Resolution Imaging Science Experiment, MRO) instruments, and the MOLA (Mars Orbiter Laser Altimeter) instrument, on board the MGS (Mars Global Surveyor), to further characterize the geomorphology and topography of the targeted areas of interest. CRISM Map-projected Targeted Reduced Data Record (MTRDR) products, e.g. [6], have proven useful in gaining insight into the chemical alteration of other ILDs in ongoing research of ILDs at Hebes Chasma; this work will build on that experience.

Initial Results: Here we present the initial results from our characterization of the physical and mineralogical properties associated with suggested volcanic ash fall and flow deposits in the ILDs of East Candor. To do this, we first categorize the possible characteristics of a volcanic ash deposit as it would currently exist (Table 1).

Table 1 – Characteristics of Possible Ash ILDs

*Mineralogical**	*Physical/Geomorphological*
Hydrated Silica, Clays, Sulfates, Zeolites	Consolidated vs. Unconsolidated, Regional layer thinning, Particle size decreasing, erosion mechanics

*Mineralogical signatures of altered volcanic ash

Within the ILDs, many physical characteristics of explosive volcanic ash deposition remain [7] and also erosional evidence of ash deposits, similar to what is seen on Earth, has been observed [1]. In a mineralogical context, however, the ILDs, including volcanic ash layers, have been altered by the evolving environmental conditions on Mars. These ash layers now exist as a variety of mineralogical species, which are known, on Earth, to originate from the alteration of volcanic ash, e.g., [8],[9] .

Figures 1 and 2 show the area of interest within East Candor, where we can observe the compositional and geomorphological characteristics of an ILD. CRISM data overlain onto HiRISE data in Figure 2 show relationships between the morphology of the layered deposits and the composition. The presence of sulfates is consistent with the presence of a volcanic ash layer, since volcanic ash falls or tuffs would contain the sulfur necessary to alter in the presence of groundwater to form sulfates [10]. With this data we are able to characterize the composition and geomorphology of each layer and look for similar layers within other ILDs.

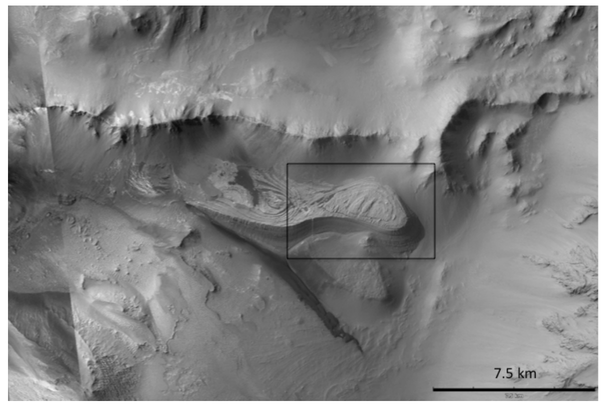

Figure 1. CTX image of East Candor, centered at -6.27 lat, -69.22 lon.

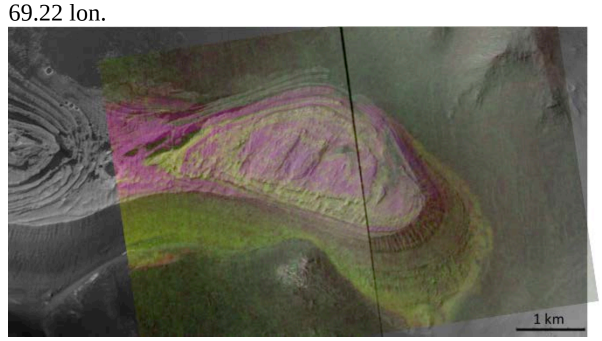

Figure 2. CRISM MTRDR image on top of HiRISE image of boxed area in Figure 1. Pink color represents polyhydrated sulfates and yellow monohydrated sulfates.

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